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(54) METHOD OF SEALING THE ENVELOPE OF A GAS-FILLED LAMP

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method of sealing a gas-filled envelope of a lamp in a closed vessel wherein the atmosphere in the vessel is substantially the same as the atmosphere required in the sealed lamp, wherein a portion of material surrounding a sealing aperture of the envelope is first heated and subsequently deformed.

A known method of working a material in a closed vessel is described in U.S. Patent Specification 3,088,201. In this known method use is made of a furnace present in the vessel which furnace heats substantially all the material introduced into the vessel simultaneously to a high temperature. A drawback thereof is that local softening and subsequent working of the material having a substantially homogeneous composition is very difficult or impossible to carry out in this vessel. In fact, either the furnace temperature is too low to obtain a sufficient softening of the material, or the furnace temperature is still so high that a softening of the material occurs, but then this softening of course also occurs on material areas which need not be worked. Small vibrations or any contact of these material areas which not be worked with another article may damage these areas. If the furnace contains a material part which is not resistant to temperatures required for the operation to be carried out on a particular component the known method described cannot be used.

The present invention provides a method of sealing a gas-filled envelope of a lamp, comprising the steps of placing the lamp to be sealed in a vessel having a wall-portion which is permeable to a laser beam, closing the vessel, filling the vessel with an atmosphere which has substantially the same composition and pressure as the atmosphere required in the sealed lamp, irradiating material in the vicinity of a sealing aperture of the lamp envelope with a laser beam which originates from a laser situated outside the vessel so that the irradiated material is at a temperature of more than 100° C. and the irradiated material is deformed so as to seal the lamp envelope after the irradiated material has reached the said temperature.

A laser is understood to mean a gastight closed gas discharge device for generating a beam of electromagnetic radiation by means of stimulated emission. This radiation may be located in the visible range or in the invisible range, such as infra-red radiation.

An advantage of a method according to the invention is that only the material to be deformed is heated. Due to the use of laser beams the temperature of the material to be heated can be increased to a high value comparatively rapidly. This high value is necessary in cases where the material to be worked has a high softening point, for example, when the material to be worked is quartz or densely sintered aluminium oxide. However, this high temperature may also be advantageous when locally working material having a softening point, or a solidification point, of less than 1000° C.

The deformation of the heated material may be established in different manners. One possibility is, for example, to cause the material in the vessel or the entire vessel to undergo a given movement. This may be a rapid revolution so that the softened material is displaced by centrifugal force. A further possibility is to work the softened material with the aid of means present in the vessel.

In an advantageous embodiment of a method according to the invention, the material is heated to above its softening point and the lamp envelope is sealed as a result of the confluence of the material which surrounds the sealing aperture.

An advantage of this method is that, after the material has been softened, the tube may be sealed by the influence of the surface tension of the material and/or by gravity. Tools or mechanisms for moving the vessel are thus not necessary.

The material sealing the aperture may have previously encompassed the aperture, for example, in the shape of a small tube or collar. It is also feasible that this sealing material was originally present in the form of a plug in the aperture which does not completely close the aperture.

If the material to be worked is quartz, a laser of the carbon dioxide type is preferably used. A carbon dioxide laser is understood to mean a laser the discharge space of which is filled with a mixture of carbon dioxide (CO_2), nitrogen together with helium and/or water vapour, the wavelength of the radiation in the beam being substantially 10.6 microns.

An advantage of this preferred method is that the heating efficiency is rather high, because the absorption of this infrared laser radiation by quartz is comparatively great.

When a carbon dioxide laser is used, the wall section of the vessel passing the light from the laser is preferably germanium but may comprise, for example, a thin sheet of ZnSe or a sheet of a different material which passes infrared radiation.

When germanium is used for this wall section, this has the advantage that the absorption, hence the losses, in that wall section are very small. The efficiency of the device can therefore be comparatively great.

It is feasible for means to be provided in the vessel or between the laser and the vessel to focus the radiation originating from the laser onto the material to be worked.

The wall section of the vessel passing the radiation from the laser may be formed as a lens. An advantage of this construction is that no additional transmission losses of the laser radiation occur which would decrease the efficiency.

In order that the invention may be readily carried into effect, an embodiment thereof will now be described in detail, by way of example, with reference to the single Figure of the accompanying diagrammatic drawing, which schematically shows a device for sealing a discharge lamp envelope.

A carbon dioxide laser 1 is capable of generating an electromagnetic beam having a wavelength of approximately 10.6 μm. This laser 1 is formed by a completely closed discharge tube 2 which is filltd with carbon dioxide, nitrogen together with water vapour and/or helium. The discharge tube 2 contains two platinum electrodes 3 and 4 having electric connections of which extend through the quartz glass cylindrical part of the tube 2. One end of this tube 2 is closed by a mirror 5 which reflects as satisfactorily as possible and the other end where the beam 6 emerges is closed by a flat mirror 7 passing part of the radiation. The laser 1 is fed from a voltage source through a variable resistor 8 and a supply unit 9. The supply unit 9 is provided with connecting terminals 10 and 11 which are connected to a voltage source.

The beam 6 of the laser 1 is projected via a mirror 12 towards a vessel 13. The laser beam passes an upper wall 14 of the vessel 13 at the area of a lens 15 which is made of germanium. The vessel 13 furthermore has two sidewalls 16 and 17. The sidewall 16 is pivotable by means of a hinge 18 relative to the upper wall 14 of the vessel 13. A hinge 19 makes it possible for the sidewall 17 to pivot relative to the upper wall 14 of the vessel 13. The lower side 20 of the vessel 13 forms part of a guideway which also includes the parts 21 and 21*a* provided outside the vessel 13. The base 20 is provided with two raised parts 22 and 23 which function as stops for the movable sidewalls 16 and 17, respectively. Part 24 represents a locking device which serves to urge the sidewall 16 against the stop 22 in a vacuum tight manner. This locking device comprises a pin 25 whose lower end is provided with a head 26. The pin 25 projects through the guideway 21. An extension spring 27 is provided between the head 26 and the guideway 21. When the spring 27 is released the upper part of the pin 25 projects just above the guideway 21. In this position this pin blocks the sidewall 16. The reference numeral 28 denotes a second locking device which serves to lock the wall section 17 of the vessel 13. The form of the locking device 28 is substantially the same as that of the locking device 24. In the arrangement shown in the Figure, a table 29 is provided in the vessel 13. A part 30 of the table 29 formed as a stop bears against the wall section 17 of the vessel 13. The table is provided with two holders 31 and 32. These holders support an unsealed envelope of a discharge lamp 33. An aperture in the wall of the discharge lamp 33 is denoted by the reference numeral 34. The lamp 33 is made of quartz. A smal ltube 35, likewise of quartz, surrounds the aperture 34. The diameter of the aperture 34 is approximately two mms.

The previously mentioned laser beam 6 impinges upon the germanium lens 15 after reflection through the mirror 12 and is then focussed by said lens 15 onto the tube 35 of the discharge lamp 33.

Two apertures 36 and 37 are provided in the base 20 of the vessel 13. The aperture 36 constitutes the termination of a supply duct 38 in the vessel 13. The apertures 37 provides access to an exhaust tube 39.

The method used with the aid of the device described will be described hereinafter.

The table 29 and the lamp 33 mounted thereon is first present outside the vessel 13, namely at the area of the guideway 21. In this situation the sidewall section 16 of the vessel 13 is placed in the open position by lifting the section 16 away from the part 22 into the horizontal position. Subsequently the table 29 and the lamp 33 present thereon are introduced into the vessel 13. This may be effected by pushing this table 29 into the vessel. It may alternatively be effected with the aid of a suitable conveyor mechanism. The table 29 is introduced into the vessel 13 until the stop 30 abuts against the sidewall section 17 placed in the closed position. Subsequently the sidewall section 16 is moved downwards so that it acquires the position shown in the Figure. The section 16 then engages the stop 22 and is secured by the pin 25 of the locking device 24.

In this situation the interior of vessel 13 is sealed from the outside atmosphere. Subsequently a suitable filler gas for the discharge lamp 33 is supplied through the supply duct 38 and the supply aperture 36. The air originally present in the vessel 13 and impurities, if any, are exhausted through the exhaust duct 39. When the desired gas atmosphere has been provided in the discharge lamp 33, the laser beam 6 is allowed to impinge on the small tube 35. Due to the great intensity of this focussed laser beam, this small tube is heated to more than approximately 1400° C. within a few seconds. The quartz of this small tube softens and the aperture 34 is sealed due to the confluence of the material of this small tube 35. At this stage the laser beam is intercepted or the laser is switched off. The laser beam may be intercepted, for example by placing a screen (not shown) in the beam which screen does not pass any or substantially any light from the laser. It is alternatively possible to use an electrically controllable light shutter such as a Kerr cell which is permanently present in the beam. A further possibility consists in moving away the mirror 12. When the radiation from the laser no longer impinges upon the discharge lamp 33, the locking device 28 is released so that the sidewall 17 can be opened in the direction indicated by the arrow. The table 29 and the sealed discharge lamp 33 mounted thereon can then be removed from the vessel 13. Subsequently the wall section 17 is closed again. The vessel 13 is then ready for sealing the next discharge lamp.

In the case described only one laser has been used, the beam of which is approximately parallel to the centre line of the aperture to be sealed in the discharge lamp. It is feasible that the laser beam may alternatively impinge upon the aperture at a given angle relative to the centre line of the aperture in the discharge lamp. This may be an acute angle but it may be 90°. It is likewise feasible than an aperture in a discharge lamp is sealed with the air of two or more lasers the beams of which are directed simultaneously and from different directions onto the material around the aperture.

In the case mentioned a method is described wherein only one discharge lamp is present in the vessel 13. It is of course possible to work a plurality of discharge lamps simultaneously in the same vessel. In that case the vessel may be provided with a plurality of windows or lenses which have a great permeability to laser radiation.

Instead of sealing the discharge lamp it is, for example, alternatively possible to seal an incandescent lamp in the vessel.

WHAT WE CLAIM IS:—

1. A method of sealing a gas-filled envelope of a lamp, comprising the steps of placing the lamp to be sealed in a vessel having a wall-portion which is permeable to a laser beam, closing the vessel, filling the vessel with an atmosphere which has substantially the same composition and pressure as the atmosphere required in the sealed lamp, irradiating material in the vicinity of a sealing aperture of the lamp envelope with a laser beam which originates from a laser situated outside the vessel so that the irradiated material is at a temperature of more than 1000° C. and the irradiated material is deformed so as to seal the lamp envelope after the irradiated material has reached the said temperature.

2. A method as claimed in Claim 1, wherein the material is heated above its softening-point and the lamp envelope is sealed as a result of the confluence of the material.

3. A method as claimed in Claim 1 or Claim 2, wherein the lamp envelope consists of silica and the laser is a carbon dioxide laser.

4. A method as claimed in Claim 3, wherein the wall-portion of the vessel consists of germanium.

5. A method of sealing a gas-filled envelope of a lamp substantially as herein described with reference to the accompanying drawing.

6. A lamp having a gas-filled envelope sealed by the method as claimed in any preceding Claim.

C. A. CLARK,
Chartered Patent Agent,
Century House,
Shaftesbury Avenue,
London, W.C.2.
Agent for the Applicants.

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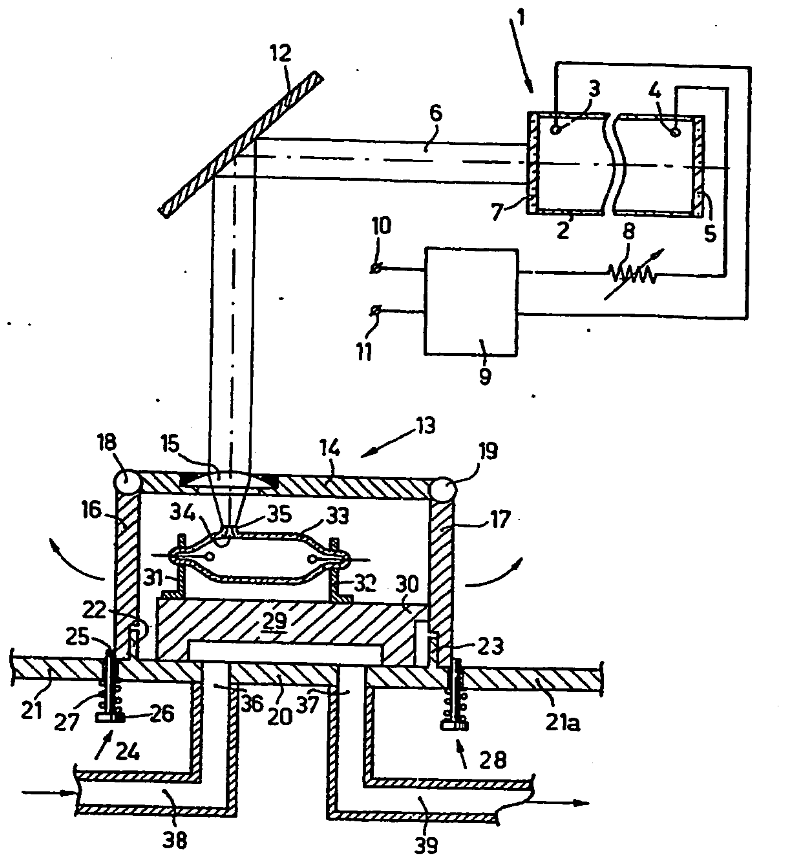
1298397 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale



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